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MEMORANDUM

DATE: December 19,1986

TO: Gene Taylor/EPA

FROM: Dave Bunte/HLN Dave Bunte

SUBJECT: ASARCO East Helena
Slag Pile Seepage Computations

COPIES: John Lucero/DEN
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INTRODUCTION

This memo summarizes computations that were made to help evaluate the results of the current slag test basin and the planned slag bottle roll tests. These computations provide an estimate of the arsenic concentration in the seepage from the slag pile that would be necessary to impact the groundwater quality.

The approach taken was to calculate what arsenic concentration in the seepage from the slag pile would raise the concentration in the groundwater from background to the drinking water standard (0.05 mg/L). The calculations were made for a range of infiltration rates from the slag pile to the groundwater.

This memo covers the basis for the calculations, a description of the calculations, and a discussion of the results. Additionally the full calculations are attached to this memo.

BASIS FOR CALCULATIONS

The calculations were based on the following assumptions:

- The quantity of water that percolates through the slag pile and infiltrates the groundwater is a fraction of the precipitation that falls on the slag pile. The percentages of precipitation to reach the groundwater used in these calculations were 5, 10, 25, and 50.

- The background arsenic concentration in the groundwater was taken to be the average of the three upgradient wells: DH-1, DH-2, and DH-3 (0.0085 mg/L).

- The flow of groundwater under the slag pile was calculated from the flow rate presented by Hydrometrics (February,1986) for the groundwater flow west of Prickly Pear Creek and east of Wilson Ditch.

- A parcel of groundwater 10 feet wide and 10 feet deep running under the slag pile was used as the boundaries for the calculation. The length of this parcel was set at 1000 feet based on the dimensions of the slag pile and the estimated direction of groundwater flow.

CALCULATIONS

The calculations will be presented here for the case where 10 percent of the precipitation that falls on the slag pile infiltrates the groundwater.

Using the area of slag that will cover the previously described parcel of groundwater as 10,000 ft^2 (10 ft X 1000 ft), the average annual volume of precipitation to fall on this area will be 9,500 ft^3. This is based on an annual precipitation of 11.4 inches (Hydrometrics Feb.,1986). Taking 10 percent of this annual volume and converting the units results in a flow of 0.051 liters per minute.

The influent flow of groundwater through this parcel is 9.4 liters per minute. This is based on Hydrometrics estimate of a flow of 1492 gallons per minute through a cross-sectional area of 60,000 ft^3 and converting to a flow through our 100 ft^3 cross-sectional area.

Calculating a mass balance around this system shows that the seepage from the slag pile would need to have an arsenic concentration of 7.7 mg/L in order to raise the groundwater concentration from 0.0085 mg/L to 0.05 mg\L. Completing the calculations for the other percentages of precipitation reaching the groundwater results in the following:

Percentage of Precipitation Reaching Groundwater	Calc. As Concentration in Seepage Needed to Raise Groundwater to 0.05 mg As/L
5	15
10	7.7
25	3.1
50	1.6

DISCUSSION OF RESULTS

These results show that an arsenic concentration of 15 mg/L in the seepage is needed to raise the groundwater to 0.05 mg/L if only five percent of the precipitation reaches the groundwater. However, if 50 percent of the precipitation reaches the groundwater, the concentration would have to be 1.6 mg/L to have the same effect. The results of these calculations help to put the impact of the seepage from the slag pile in perspective with other sources of groundwater contamination. For example, if it is assumed that 10 percent of the precipitation reaches the groundwater and the seepage from the slag pile is shown to have a concentration of less than approximately 7.7 mg/L (from the tests in progress), then then the contribution of the slag pile to the groundwater contamination can be considered small relative to other sources. This is considering the groundwater under the slag pile has a concentration of 10 mg As/L in some areas and the 7.7 mg/L seepage would only raise the arsenic concentration by 0.042 mg/L. If, however, there were no other sources of groundwater contamination then this impact could be considered significant.

The limitations of these calculations must be considered when evaluating the results. These limitations include:

- The seepage rate through the slag pile was based on a yearly average and short term impacts could be much greater than calculated here.

- A calculated average groundwater flow was used, and substantial variations from this flow could occur in localized areas resulting in impacts other than calculated here.

SUBJECT Slag Pile Seepage Calculations BY DJB DATE 12/22
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Purpose:

To determine the arsenic concentrations in the seepage from the slag pile that would cause a significant change in the groundwater quality.

This "significant change" was set for these calculations as the conditions required to raise the arsenic concentration from background to drinking water standard (0.05 mg/L).

Approach:

1] Estimate background arsenic concentration in groundwater. Use average of DH-1, DH-2, and DH-3.

2] Define boundaries for calculations.
- Select parcel of groundwater under slag pile with a cross-sectional area (perpendicular to groundwater flow) of 100 ft^2 (10 ft. wide and 10 ft. deep.
- Select length of parcel as 1000 ft. This is based on the dimensions of the slag pile and the direction of the flow under the slag pile. 1000 ft represents a typical length of flow under the pile.

3] Use a percentage of the annual precipitation as the amount of precipitation that percolates through the slag and infiltrates the groundwater under the slag pile. Use the percentages 50, 25, 10, and 5 to develop the sensitivity to this variable.

Basis:

1] Use all ASARCO analytical results in calculation of average background groundwater quality. Use values of less than detection limit (0.004 mg/L As) as equal to detection limit. Also, average replicates prior to calculation.

2] Use data from Hydrometrics (Feb. 1986) for calculation of groundwater flow. Use flow given for area east of Wilson ditch and west of Prickly Pear Creek.

3] Use 11.4 inches as average annual precipitation rate (Hydrometrics, Feb, 1986).

Calculations:

- Background As concentration: (Data from Hydrometrics Feb '86)
  - DH-1 analyses = <0.004, 0.007, 0.007, <0.004 ; Avg = 0.0055
  - DH-2 analyses = 0.008, 0.008, 0.018, 0.007 ; Avg = 0.0103
  - DH-3 analyses = 0.007, 0.008, 0.012, 0.012 ; Avg = 0.0098

  Average = $0.0085 \frac{mg\ As}{L}$

- Calculate As concentration in seepage from slag pile that would be necessary to raise gw conc to 0.05 mg/L for 10% of precip. reaching groundwater.

  - Precipitation:

    Use 10,000 ft² area (10 ft x 1000 ft) subject to precipitation above parcel of ground water defined previously.

    $$10{,}000\,ft^2 \times \frac{11.4\,in}{yr} \times \frac{1\,ft}{12\,in} = 9{,}500\,ft^3/yr$$

    For 10% reaching gw:

    $$\frac{9{,}500\,ft^3}{yr} \times 0.1 \times \frac{28.3\,L}{ft^3} \times \frac{yr}{365\,day} \times \frac{day}{1440\,min} = 0.051\,\frac{L}{min}$$

  - Groundwater flow:

    From Hydrometrics (Feb, 1986), gw flow = 1492 gpm for 60,000 ft² cross-sectional area. For 100 ft² area:

    $$1492\,\frac{gallons}{min} \times \frac{100\,ft^2}{60{,}000\,ft^2} = 2.49\,\frac{gallons}{min}$$

    $$2.49\,\frac{gal}{min} \times \frac{3.785\,L}{gal} = 9.41\,L/min$$

- Mass balance:

Total As mass in effluent $= (9.41 + 0.051)\frac{L}{min} \times 0.05 \frac{mg\ As}{L}$

$= 0.473 \frac{mg\ As}{min}$

As Mass in influent $= 9.41 \frac{L}{min} \times 0.0085 \frac{mg\ As}{L} = 0.08 \frac{mg\ As}{min}$

As Mass in seepage $= 0.473 \frac{mg}{min} - 0.08 \frac{mg}{min} =$

$= 0.393\ mg/min$

As conc. in seepage $= 0.393\ mg/min \cdot \frac{min}{0.051 L} = \boxed{7.7 \frac{mg\ As}{L}}$

- For 50% of ppt reaching the groundwater

Flow of seepage $= 0.256\ L/min$

Total As mass in effluent $= (9.41 + 0.256)\frac{L}{min} \times 0.05 \frac{mg}{L} = 0.483 \frac{mg\ As}{min}$

As mass in influent is as above $= (0.08 \frac{mg\ As}{L})$

As mass in seepage $= 0.483 \frac{mg}{min} - 0.08 \frac{mg}{min} = 0.403 \frac{mg\ As}{min}$

As conc in seepage $= 0.403\ mg/min \cdot \frac{Min}{0.256 L} = \boxed{1.6 \frac{mg\ As}{L}}$

- For 25% of ppt reaching the groundwater:

Flow of seepage $= 0.128\ L/min$

Total As mass in effluent $= (9.41 + 0.128)\frac{L}{min} \times 0.05 \frac{mg}{L} = 0.477 \frac{mg}{min}$

As conc in seepage $= (0.477 - 0.08)\frac{mg}{min} \times \frac{min}{0.128 L} = \boxed{3.1 \frac{mg\ As}{L}}$

- For 5% of ppt reaching the groundwater

Flow of seepage $= 0.0256\ L/min$

Total As mass in effluent $= (9.41 + 0.0256)\ L/min \times 0.05\ mg/L = 0.472\ mg/min$

As conc in seepage $= (0.472 - 0.08)\ mg/min \times \frac{min}{0.0256 L} = \boxed{15.3 \frac{mg\ As}{L}}$

Summary:

Shown below is the concentration of As that would be necessary in the seepage from the slag pile to raise the As in the groundwater from background (0.0085 mg/L) to the Drinking water standard (0.05 mg/L).

This data is shown for four different percentages of precipitation reaching the groundwater through the slag pile:

Percentage of Precipitation Percolating through the Slag Pile and Reaching GW	Concentration of As in the Seepage from the Slag Pile that would be necessary to Raise GW to 0.05 mg/L
50	1.6 mg As/L
25	3.1
10	7.7
5	15